"FerMiQ" Project

New Analytical Methods Improve the Stability of Processes in Biogas Plants

A sustainable and stable process is a fundamental prerequisite for efficient and economic operation of a biogas plant. It is therefore necessary to make regular checks on process stability and nutrient status of the fermenter as well as on the quality and biogas potential of the input substrate. In view of the highly complex nature of the process biology in the biogas fermenter and the manifold interactions and interdependencies between the microbial groups present, there remains considerable potential for development with regard to the analytical methods employed. Combinations of well-established analytical chemical methods with the latest molecular-biological techniques appear particularly promising. And that is what the research project "FerMiQ" is all about: PFI Biotechnology and AMODIA Bioservice are developing a novel procedure for quantitative analysis of fermenter microbiology in biogas plants with the intention of deriving recommended codes of practice for optimised operation of biogas plants.

Alpha and Omega: Effective Process Monitoring

Germany's biogas sector is currently facing huge challenges, not least arising from numerous changes and revisions of the country's Renewable Energy Sources Act (Erneuerbare Energien Gesetz, EEG), which are making economic plant operation using classical input substrates increasingly difficult. Discontinuation of the renewable resources bonus on use of energy crop plants in combination with the cap on the use of maize has led to increased interest in the use of alternative substrates. There is considerable demand for low-cost residual and waste materials such as green horticultural waste, straw, manure, and poultry dung.

However, greater use of these alternative substrates poses a considerable challenge with regard to plant control and stable and trouble-free fermentation. A sometimes higher degree of lignification of the input materials and/or high nitrogen loads can adversely affect the microbial degradation process the biogas fermenter and – in the case of inadequate process monitoring – lead to severe disruptions. Moreover, the so-called flexibilisation bonus meanwhile claimed by many plant operators increases the effort required for process monitoring owing to the discontinuous operating mode of the fermenter.

Process biology monitoring services offered in the marketplace are still essentially limited to classical physical and chemical analyses of fermenter samples. The main focus of these analytical procedures is on certain metabolites (volatile organic acids), nutrients, and trace elements as well as potentially inhibiting substances (such as ammonium). A crucial problem with these procedures is that any unusual values of the relevant measurements are frequently discovered only after a process-biological malfunction has already begun or is already well advanced. In contrast, molecular-biological method can

recognise imbalances within complex microbial communities earlier that physicochemical methods. They permit earlier corrective intervention and hence improved process stability.

Molecular-biological Procedures for Quantification of Microorganisms Permit Early Recognition of Process Malfunctions

Against this background, the project partners PFI and AMODIA are planning the development of a molecular-biology based analytical service for assessment of biogas fermenters by quantification of pertinent microbial groups. The objective is to achieve early detection of impending process-biological malfunctions at the level of the composition of microbial communities by means of specific molecular-biological analytical techniques. The procedure should be suitable both for routine process control and also for more intensive monitoring and analysis of the fermentation process in critical operating states. This applies in particular to the use of new substrates or additives and also to restarts after maintenance or shut-downs. In order to achieve this goal, the research project partners have pooled their extensive specialist knowledge in the areas of process biology, nutrient and trace element analysis as well as in the characterisation of microbial groups and the development of molecular-biology based analytical techniques.

Fig. 1: Improved monitoring methods for stable processes in biogas plants is the objective of PFI Biotechnology's new "FerMiQ" research project. Photo: Phillip Pohlmann for Pixelio

An important aspect of process development has been the effective practical support we have enjoyed. Numerous plant operators regularly placed their fermenters and substrate samples at our dis-

posal for chemical and molecular-biological analyses. These data from ongoing practical plant operation constitute an important basis for development of analytical methods. In parallel, extensive fermentation experiments were conducted on a laboratory and pilot scale, in which various operating states and, in particular, well-defined process-biological malfunctions could be simulated. Successful testing under real-life conditions should lead to a standardised analytical procedure which offers plant operators a means of fast and cost-favourable monitoring of process biology. Above all, it should be possible to recognise critical plant operating states at an early stage and thus avoid time-consuming process malfunctions resulting from lack of nutrient or change of feed. This development would represent an enormous advance in the area of process control and process monitoring.

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